INDOOR AIR QUALITY ASSESSMENT

Gerena Magnet School
200 Birnie Street
Springfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment

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Background/Introduction

At the request of Judy Dean, Western Massachusetts American Lung Association, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH) Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Gerena Magnet School (GMS), 200 Birnie Street, Springfield, Massachusetts. Nursing staff at this school raised concerns about indoor air quality, especially in the special needs classroom area.

On February 13, 2004, a visit to conduct an indoor air quality assessment was made to this school by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA. Mary Zamorski, Nursing Supervisor, Springfield School Department and Ms. Dean accompanied Mr. Feeney during this evaluation.

The GMS is a two-story complex reportedly constructed in 1975. The complex consists of a main building, which spans the length of the Interstate Highway 91 (I-91) overpass, and an underground structure referred to as the GMS Annex (Map 1). The main GMS building is the subject of this report, whereas the GMS Annex is the subject of a separate report.

The GMS main building consists of general classrooms, art rooms, science classrooms, library, auditorium and main office area. Classrooms are arranged in a "pod" system, with four-foot dividers, shelves and/or walls serving as partitions in large open room. The center of the building contains a large, multiple story, enclosed atrium (Picture 1). The atrium provides access to the GMS Annex, as well as the cafeteria and additional classrooms situated in the underground level. Classroom areas along exterior walls have openable windows. No openable windows exist in the underground areas of the GMS main building.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The GMS has approximately 800 students in pre-kindergarten through fifth grade and a staff of approximately 60. Tests were taken at the school during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 ppm (parts per million) in five of twenty-three areas surveyed, indicating a ventilation problem in some areas of the school. It should be noted however, that a number of areas with carbon dioxide levels below 800 ppm had either open windows or were sparsely populated. These factors can greatly contribute to the reduction of carbon dioxide levels.

Mechanical ventilation is provided by a heating, ventilating and air conditioning (HVAC) system. Fresh air to classroom pods is provided by rooftop-mounted AHUs (Picture 2). Supply ducts connect the AHUs to the ceiling mounted air diffusers, which are located in light fixtures of each room (Picture 3). Air diffusers are equipped with fixed louvers that direct the air supply along the ceiling and down walls. In this manner, airflow is created. Exhaust ventilation throughout the building is provided by ceiling and/or wall-mounted exhaust vents.

Unit ventilator systems (univents) supply fresh air to small classroom areas, or minipods (Picture 4) (Table 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. Univents have three controls: low, high and off. Univents were turned off in classrooms throughout the school. In order for univents to provide fresh air as designed, these units must remain "on" and allowed to operate while rooms are occupied. Furthermore, intakes must remain free of obstructions.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times a room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilation system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix A.

Temperature readings ranged from 70^o F to 74^o F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building ranged from 16 to 19 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A letter detailing possible mold contamination identified in classrooms in the GMS and Annex was issued by BEHA prior to this report (Appendix B) (MDPH, 2004). Of note is water penetration in below grade areas, directly beneath the footprint of the school. The rear wall of the atrium showed signs of efflorescence and peeling paint (Picture 5), which indicate water penetration. Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. Brick, cement and mortar are not generally good mold growth media. As moisture penetrates and works its way through mortar and brick, water-soluble compounds in brick and mortar dissolve, creating a solution. As the solution moves to the surface of brick or mortar, the water evaporates, leaving behind white, powdery mineral deposits.

In contrast to brick and cement, ceiling tiles can be a mold growth medium, particularly if moistened repeatedly without drying. Of note were missing ceiling tiles due to water damage in the pod area below the media center. Ceiling tiles along the exterior (foundation) wall were missing in this room. The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (ACGIH, 1989; US EPA, 2001). If porous materials are not dried within this time frame, mold growth may occur. Cleaning cannot adequately remove mold growth from water damaged porous materials. The application of a mildewcide to moldy porous materials (e.g., ceiling tiles) is not recommended.

The grounds around the GMS building exterior may also provide a source of moisture. Railroad tracks parallel the rear of the school. A chain link fence separates the tracks and the building (Picture 6). Trees, weeds, and standing water were seen in the gap between the building and the tracks. The growth of roots against exterior walls can bring moisture in contact with the walls, which can eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through foundation concrete and masonry via capillary action (Lstiburek & Brennan, 2001).

A bird was noted to be roosting on the exterior window framework of the atrium, and bird waste was seen on the side of atrium window on interior support beams (Picture 7). Bird wastes in a building raise concerns because of diseases that may be caused by exposure to bird wastes. Certain molds associated with bird waste are of concern, especially for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune-compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials. Considering the health affects of bird wastes, the need for clean up of bird waste and appropriate disinfection is imperative.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes has required clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

Lastly, several areas had plants. A number of these plants did not have drip pans. Plant soil and drip pans can serve as a source of mold growth. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were measured between 0 to 1 ppm (Table 1). Carbon monoxide levels measured in the school reflect levels measured outdoors.

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment. Outdoor PM2.5 concentrations were measured at 36 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the school were below levels measured outdoors. Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs

(TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were non-detect (ND) (Table 1). Indoor TVOC measurements throughout the building were also ND. Please note, TVOC air measurements reported are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While TVOC levels were ND, materials containing VOCs were present in the school.

Of note is the use of different VOC containing products in the building. Rubber cement was noted in some classrooms. Rubber cement contains n-hexane or heptane, which can be irritating to the eyes, nose and throat. In addition, n-hexane and heptane are extremely flammable materials. Local exhaust ventilation should be utilized when this material is used. As required by the federal Labeling of Hazardous Art Materials Act (LHAMA), art supplies containing hazardous materials that can cause chronic health effects must be properly labeled (USC, 1988). The use of art supplies containing hazardous materials that can cause chronic health effects should be limited to times when students are not present and in areas where adequate exhaust ventilation is available.

Some classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs) (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve), which can be irritating to the eyes, nose and throat (Sanford, 1999).

The teachers' room contains photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Minipod 5 contains a laminator. Lamination machines can give off waste heat and odors. To help reduce excess heat and odors in these areas, school personnel should ensure that local exhaust ventilation is activated when equipment is in use.

Of note is the use of individually purchased cleaning materials in the GMS. Cleaning materials frequently contain ammonia compounds or sodium hypochlorite (e.g. bleach products), which are alkaline materials. The use of these products can provide exposure opportunities for individuals to a number of chemicals. Exposure to such chemicals can lead to irritation of the eyes, nose or respiratory tract. Cleaning products containing respiratory and skin irritants appear to be used throughout the building.

Several other conditions that can affect indoor air quality were noted during the assessment. Food storage containers were noted in some classrooms. If not properly stored, food can create conditions that attract pests, such as ants. Under current Massachusetts law (effective November 1, 2001), the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritation. The reduction/elimination of pathways/food sources that are attracting these insects should be the first step taken to prevent or eliminate an infestation.

Lastly, of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or cleaned periodically to avoid excessive dust build up.

Conclusions/Recommendations

The following recommendations are based on observations made at the time of this assessment:

1) Operate all functional mechanical ventilation systems continuously and independent of classroom thermostat control to maximize air exchange during periods of school occupancy.
2) Examine each AHU and univent for function. Survey each classroom to ascertain whether an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of air control dampers building-wide.
3) Consult a ventilation engineer concerning re-balancing of the ventilation systems. Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
4) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with

wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

5) Remove all blockages from univents to ensure adequate airflow.

6) Consider the following actions to prevent moisture penetration into the building:

    a) Remove foliage to no less than five feet from the foundation.

    b) Improve the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek & Brennan, 2001).

    c) Install a water impermeable layer (e.g. clay cap) on ground surface to prevent water saturation of ground near foundation (Lstiburek & Brennan, 2001).

7) Remove birds' nests from exterior of building. To prevent possible exposure to bird wastes, implement the corrective actions recommended by the CDC (CDC, 1998). To prevent possible spread of bird waste particulates to occupied areas, employ the methods listed in the SMACNA guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

8) Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial when necessary.

9) Examine the feasibility of providing local exhaust ventilation for the photocopier/lamination machines or relocate equipment to an area with adequate exhaust ventilation.

10) Reduce the use of cleaning materials that contain respiratory irritants (ammonia containing compounds) on floors and in classrooms. Substitute plain soap and hot

water for ammonia related cleaning products. Cleaning products that contain ammonia should only be used where necessary. If ammonia containing cleaning products is used, rinse the area of application with water to remove residue.

11) Use the principles of integrated pest management (IPM) to prevent infestation of pests. A copy of the IPM recommendations from the Massachusetts Department of Food and Agriculture (MDFA, 1996) can be obtained at the following website: http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf. Activities that can be used to eliminate pest infestation may include the following:

    a) Evaluate the use of food as components in student artwork.
    b) Rinse recycled food containers. Seal recycled containers with a tight fitting lid to prevent rodent access.
    c) Remove non-food items that could be consumed by rodents.
    d) Store food in tight fitting containers.
    e) Avoid eating at workstations. In areas where food is consumed, periodically vacuum to remove crumbs.
    f) Clean crumbs and other food residues from ovens, toasters, toaster ovens, microwave ovens, coffee pots and other food preparation equipment on a regular basis.
    g) Examine each room and the exterior walls of the building for means of rodent egress and seal. Holes as small as ¼” are enough space for rodents to enter an area. If doors do not seal at the bottom, install a weather strip as a barrier to rodents. Reduce harborages (e.g. cardboard boxes) where rodents may reside (MDFA, 1996).

12) Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

13) Consider adopting the US EPA (2000b) document, *Tools for Schools*, to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

14) Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Picture 1

The Atrium

Picture 2

Rooftop AHU

Picture 3

Ceiling Mounted Fresh Air Supply

Picture 4

Minipod Univent (With Front Cover Removed By BEHA Staff)

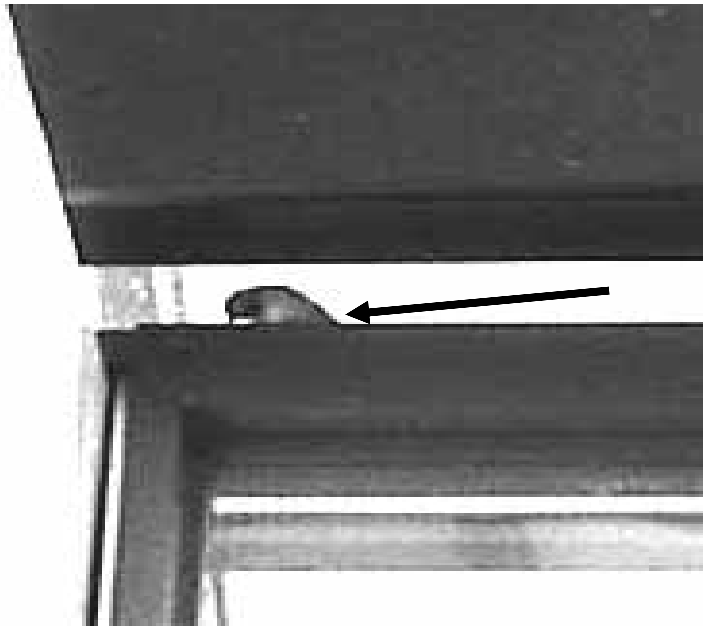
Picture 5

Rear Wall of the Atrium with Efflorescence and Peeling Paint

Picture 6

The Area between the Chain Link Fence, Tracks and the Rear Exterior Wall Containing Trees, Weeds and Standing Water

Picture 7



Bird in Atrium

Gerena Magnet School **Indoor Air Results**

200 Birnie Avenue, Springfield MA **February 13, 2004**

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background (outdoors)	47	20	341	0	0	36			-	-	
Minipod 5	72	16	634	1	0	15	2	Y	Y	Y	Supply blocked by furniture and boxes; laminator
Pod 4	72	16	472	1	0	13	0	Y	Y	Y	Plants, food storage/use, cleaners
Teachers' room	72	19	755	1	0	12	4	Y	Y Univent	Y Wall	2 PC; ozone odor
Pod 5	73	17	767	1	0	19	50+	N			DEM, plants, food/storage, clutter; WD carpet, 2 WD CT
Pod 9	71	17	555	1	0	9	0	N			DEM, plants, food/storage, clutter, cleaners
Minipod 9	72	17	641	1	0	10	0	N	Y	Y	Supply blocked by clutter and boxes; plants, food/storage, clutter

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier
BD = backdraft
CD = chalk dust

CT = ceiling tile
DEM = dry erase marker
DO = door open
GW = gypsum wallboard
ND = non detect
MT/AT = missing tile/ajar tile
PC = photocopier

PF = personal fan
PS = pencil shavings
TB = tennis balls
UF = upholstered furniture
UV = univent
WD = water damage

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Gerena Magnet School | **Indoor Air Results**

200 Birnie Avenue, Springfield MA | **February 13, 2004**

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Pod 10	72	17	580	0	0	12	39	N	Y Ceiling	Y Ceiling	DEM
Minipod 10	71	17	679	0	0	16	14	N	Supply in pod 10	N	Minipod open to hallway
Pod 8	72	18	741	1	10	11	80+	Y	Y Ceiling	Y Ceiling	DEM, food storage/use, clutter, rubber cement
Minipod 8	27	19	913	1	0	12	14	N	Y Univent	Y Ceiling	Univent blocked by clutter and boxes; food storage, clutter
Minnipod 2	72	17	665	1	0	8	3	N	Y Univents	Y Ceiling	Univents blocked by clutter; food storage/use
Minipod 1	72	18	804	1	0	7	7	Y	Y Univent		Food storage/use
Pod 1	73	19	844	1	0	12	50+	Y	Y Ceiling	Y Ceiling	Food storage/use

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Art 1	72	17	650	1	0	9	0	N	Y Ceiling	Y Wall	
Pod y	73	18	718	1	0	10	80+	7	Y Ceiling	Y ceiling	DEM, food storage/use, clutter
Minipod 7	74	18	829	1	0	10	0	Y	Y Univents	Y Wall	DEM
Pod 6	73	17	832	1	0	16	80+	Y	Y Ceiling	Y Ceiling	DEM, food storage/use, clutter
Minipod 4	72	16	488	1	0	17	0	Y	Y Univents	Y Closet	Univents blocked by plastic boxes
Minipod 3	72	16	540	1	0		0	N	Y Univents	Y Wall	Univents blocked by clutter and boxes; DEM, food storage/use

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier
BD = backdraft
CD = chalk dust

CT = ceiling tile
DEM = dry erase marker
DO = door open
GW = gypsum wallboard
ND = non detect
MT/AT = missing tile/ajar tile
PC = photocopier

PF = personal fan
PS = pencil shavings
TB = tennis balls
UF = upholstered furniture
UV = univent
WD = water damage

Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems		

Gerena Magnet School

200 Birnie Avenue, Springfield MA

Table 1

Indoor Air Results

February 13, 2004

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Pod 3	72	16	469	1	0	7	0	Y	Y Ceiling	Y Ceiling	DEM
Pod 2	73	16	616	1	0	7	0	Y	Y Ceiling	Y Ceiling	Clutter, cleaners
Cafeteria	70	19	557	1	0	16	100+				
Atrium level pod	72	17	532	1	0	10	30		Y Ceiling	Y Ceiling	9 WD-CT; 1 CT with visible mold growth; 2 MT/AT; musty odor

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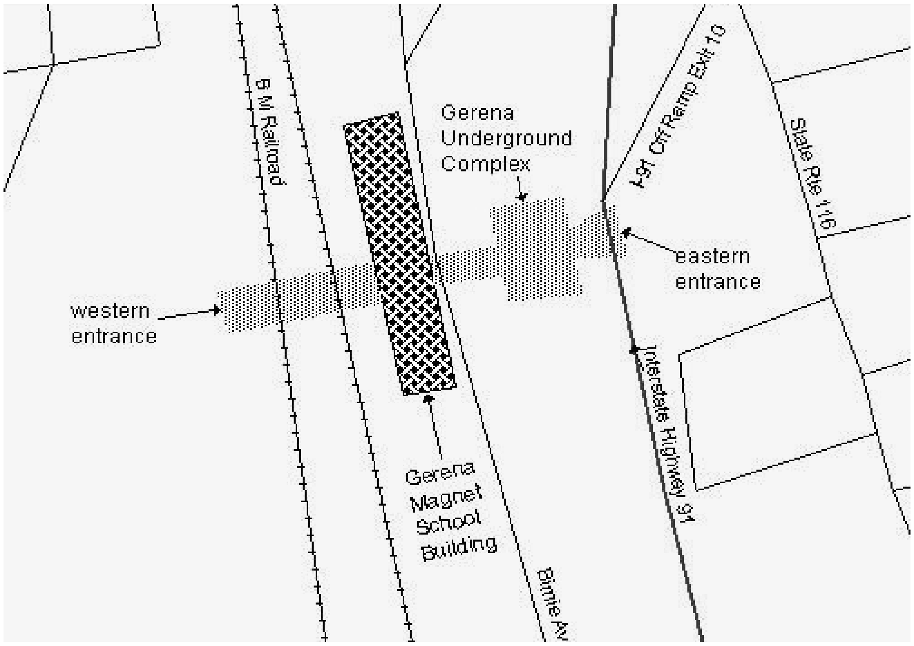
Map 1



Footprint of Gerena Magnet School Complex